DOCUMENT RESUME

ED 238 302 FL 014 174

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TITLE	Normal Aging and Linguistic Decrement.
INSTITUTION	National Inst. on Aging (DHEW/PHS), Bethesda, Md.
PUB DATE	19 Nov 83
GRANT	5T32AG00039
NOTE	28p.; Paper presented at the Annual Scientific Meeting of the Gerontological Society of America (36th, San Francisco, November 19, 1983).
PUB TYPE	Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Adults; Age Differences; *Aging (Individuals); Comparative Analysis; *Diseases; *Language Handicaps; Language Patterns; *Language Processing; Language Research; Middle Aged Adults; Neurolinguistics; *Older Adults
IDENTIFIERS	*Alzheimers Disease

ABSTRACT

A study investigated language patterning, as an indication of synthetic mental activity, in comparison groups of normal pre-middle-aged adults (30-42 years), normal elderly adults (75-93), and elderly adults (71-91) with Alzheimer's dementia. Semiotic theory was used as the conceptual context. Linguistic measures included the Token Test, the Boston Diagnostic Aphasia Examination, and the Test for Syntactic Complexity. Results showed significant differences between pre-middle-aged and normal elderly in linguistic processing, indicating a direct relationship between language deficits and increased age. There also appears to be a definitive pattern in age-correlated deficits, showing non-random, predictable linguistic decrement. There is a direct relationship between language deficits and linguistic complexity within and across semiotic ranks, and an inverse relationship between language deterioration and language development. (MSE)

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Presented at the Annual Scientific Meeting of the Gerontological Society of America (36th, San Francisco, California, November 19, 1983).

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NORMAL AGING AND LINGUISTIC DECREMENT

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F-014174

FOOTNOTES

NORMAL AGING AND LINGUISTIC DECREMENT[1]

[1] Supported in part by National Institute on Aging Grant 5T32AG00039. Presented in part at 36th Annual Scientific Meeting of Gerontological Society of America, November 19, 1983. Awarded a Walter Nicolai Prize for Biomedical Gerontological Research by American Aging Association, 1983. Acknowledgments to the late Dr. Robert Kahn, Department of Psychiatry, University of Chicago; Dr. William Darden, Chairman, Department of Linguistics, University of Chicago; Dr. Mihaly Csikszentmihalyi, Chairman, Committee on Human Development, University of Chicago; and Dr. Paul Emery, Department of Psychiatry, Dartmouth Medical School.

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NORMAL AGING AND LINGUISTIC DECREMENT[1]

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The study to be discussed involves the investigation of language patterning, as an indicator of higher order cortical process (APA, 1980; Brown, 1973), or as synthetic mental activity (Luria, 1980), in the comparison groups of normal pre-middle-aged adults, normal elderly adults, and elderly adults with senile dementia of the Alzheimer type. The study was exploratory with the following objectives: (1) to establish methods for the investigation of linguistic patterning in adulthood in both normal and pathological manifestations, (2) to analyze samples of normative linguistic patterning at two age points in the adult segment of the life cycle, (3) to determine if there is a significant difference in linguistic patterning at the two age points, and to analyze the structure of such a difference, (4) to analyze the similarities and differences between the structure of deficits in normal aging and in senile dementia of Alzheimer's type, and (5) to see what is the relation between measures of linguistic patterning (Token Test, Test for Syntactic Complexity, Boston Diagnostic Aphasia Examination) and measures of other higher cortical processes such as memory (Wechsler Memory Scale) and thought (Piagetian Tests for Concrete Operations). The present paper will be delimited to a discussion of the significant differences in language patterning between the normal elderly and the normal pre-middle-aged adults; for an analysis of the language structure in senile dementia Alzheimer's type, and comparisons with language structure in normal aging, see Emery, 1982, 1983a, 1983b; Emery & Emery, 1983. The data pertaining to the mental activities of memory and thought are presented elsewhere also, Emery, 1982, 1983c.

The focal research problem of linguistic patterning in late life relates to the general question of what are the qualitative and quantitative changes in higher order cortical processes during the latter part of the life span. Memory, attention, perception, thought, and language are higher order cortical functions. While there is ongoing research, dialogue, and debate relating to the issue of decremental age changes in the functions of memory, perception, attention, and thinking (Birren & Schaie, 1977; Botwinick, 1978; Botwinick & Storandt, 1974, 1980; Craik & Simon, 1980; Denney & Denney, 1982; Denney & Wright, 1976; Horn & Donaldson, 1977; Poon, 1980), there is a paucity of systematic research relating to the synthetic mental function of language in

the aged. The research inattention to language is evidenced in the lack of inclusion of the term 'language' in the indices of many major research compendia on aging; and yet, language is an important higher order mental process, indispensable for normative human interaction.

An analysis of what limited research exists on the topic shows some interesting findings on the relation between language deterioration and normal aging, although these findings, for the most part, lack embeddedness in a nomological network. In these previous studies, it was found that normal elderly adults perform significantly worse than younger adults on measures of phonological competence (Benjamin, 1982), auditory comprehension not attributable to hearing impediments (Obler & Albert, 1981), naming competence (Goodglass, 1980), quality of definition at the lexical level (Botwinick et al., 1975), speed of encoding and decoding (Salthouse & Somberg, 1982), and semantic processing (Cohen, 1979; Eysenck, 1974). Further, Obler and Albert (1981) found that active as opposed to passive vocabulary skills may deteriorate with normal aging, while Bowles and Poon (1981) found that normal aging does not affect speed of lexical access, which may be interpreted as a passive vocabulary or lexical function. Also, it was found that the normal elderly have greater difficulty with semantic processing of connected prose material as opposed to the processing of discrete words (Craik & Masani, 1967; Gilbert & Levee, 1971); put in the perspective of the research to be delineated in this paper, the normal elderly have greater difficulty with semantic processing at the syntactic as opposed to lexical level of the semiotic hierarchy (Emery, 1983c). Finally, Benton and associates (1981) found that although language skills may show decrement in the normal aged, such decrement is in evidence primarily after eighty years of age. The above studies will be commented on further at a later point in this discussion; many of the disparate findings of the foregoing will become understandable, revealing a configuration, in the context of our own research results.

The Linguistic Context

Language is a system of codes, evolved for the purpose of communication. The use of language involves the processes of encoding and decoding of symbols and signs. Further, language is a system of rules, requiring the mental processing and integration of varying forms and sets of relations. A word, for example, is a complex multi-dimensional matrix of differing cues and connections.

The formal aspects of linguistic patterning which were evaluated in the

present study were analyzed in the context of the semiotic theory of signs; the semiotic system is hierarchical, going from simple to more complex units of speech, corresponding roughly to sound, part of word/word, sentence, and expressed meaning/utterance (Jakobson, 1964). There are qualitative as well as quantitative differences at each hierarchical level, with categorical ranks of phonology, morphology, syntax, and semantics (Saussure, 1916). It is these categories which were used to analyze and order the data relating to the structure and sequence of linguistic patterning in the contrast groups of normal pre-middle-aged adults, normal elderly adults, and elderly adults with senile dementia of the Alzheimer type.

Phonology refers to the phonetic and phonemic systems of language; both systems involve the analysis of sound without reference to meaning. Phonetics refers to the analysis of sound-producing processes; phonemics is the analysis of phonemes, which are not sounds per se (which is the domain of phonetics), but rather are features of sound which the speakers have been socialized to recognize and produce in the current of actual speech sound (Bloomfield, 1933). Morphology is the study of morphemes; a morpheme is the smallest unit of meaningful linguistic signalling. Morphology involves the analysis of parts of words and words, but never phrases or sentences. The total stock of morphemes in a language is its lexicon. Our study involved two kinds of morphological analyses: (1) lexical or vocabulary competence, and (2) word-internal morphological analysis (Darden, 1982) in which we analyzed subject performance related to word inflection.

Syntax is the analysis of the structure of phrases and sentences; variables of syntax include differing sentence types, forms of substitution, linear word order, differing kinds of clauses, pronomial and prepositional usage, and forms of propositional relations (Bloomfield, 1933). Variation in these syntactical elements can be ordered on the overlapping dimensions of complexity-simplicity, logicality-alogicality, and abstraction-concreteness (Brown, 1973; Dale, 1976; Svedelius, 1897). The differentiation of syntactic models into the complex, logical, and abstract as opposed to the simple, alogical, and concrete has served as the basis for the testing and discrimination of brain damaged from normal populations by Jackson (1884), Head (1926), Goldstein (1942), Luria (1973, 1980) and others who found that organic brain deficit hinders or prevents comprehension of complex, logical, abstract, syntactic forms. However, these previous findings were based primarily on patient

populations of accident, war, and tumor victims; systematic syntactic testing of normal elderly persons on the above parameters had not been done prior to our research insofar as we know.

Semantics, the final category of semiotics to be considered, refers to (1) the analysis of meaning, (2) the branch of semiotic theory dealing with the relation between signs and that which they denote. In discussing semantics Jakobson stated that there are two basic modes of relation: the internal relation of similarity (equivalence) and the external relation of contiguity. The speaker and hearer must have a common denotational and connotational system, a common code and common context, in order to understand one another.

To conclude this outlining of semiotic categories, four ranks of increasing complexity have been described because they comprise the context for the investigation of language patterning in the elderly.

METHOD

Participants

This study of language and aging had as participants normal pre-middle-aged adults (ages 30-42), normal elderly adults (ages 75-93), and elderly adults with senile dementia Alzheimer's type (ages 71-91); the mean age of each group was 36.4, 83.35, and 80.25 respectively. Each sample consisted of 20 persons (10 men and 10 women). In the selecting of normal subjects, criteria for normalcy included a history of good physical and mental health, lack of chronic illness, and normative everyday function; physical screening included hospitalization history and only persons without compromised major organ systems participated as subjects. No person with cardiovascular, neurological, or metabolic signs was included as a study participant; all subjects had blood pressure readings within the normal range.

The research design included careful controls over demographic variables. The variable of race was held constant; all subjects were white. Cohort differences, such as differential education (Birren & Schaie, 1977; Botwinick, 1975), were controlled within and between samples, through the participant requirement of being no more and no less than a high school graduate. Controls were used to ensure comparability on the parameter of literate socialization (Emery & Csikszentmihalyi, 1981a, 1981b), as well as on current reading habits. All subjects were native Americans with American born parents of English-speaking background; no bilingual persons were included in the study. Each sample con-

sisted of ten men and ten women in order to avoid confounding study results with possible sex differences in language skills. Participants were residents of Illinois, New Hampshire, or Massachusetts at time of interview. The normal elderly sample was secured with the assistance of several physicians who provided names of optimally healthy elderly persons who met other study criteria.

Since the focus of this paper is on comparisons between the normal pre-middle-aged and normal elderly adults, and data pertaining to the elderly with Alzheimer's dementia are analyzed elsewhere (Emery, 1982, 1983a, 1983b; Emery & Emery, 1983), the criteria for selection of the Alzheimer sample will not be discussed except insofar as to mention the instruments used in sample selection, because in the interest of holding study conditions constant, these instruments were administered also to the normal samples; they were found to be useful in the screening of hitherto unrecognized physical and/or mental pathology. The instruments were the Face-Hand Test, Kahn-Goldfarb Mental Status Questionnaire, Hamilton Depression Scale, and Langner Depression Scale supplemented by a special symptoms list (Kahn & Miller, 1978). Further, to prevent inadvertent inclusion of chronic schizophrenics in the sample, an Interview for Psychosis was devised jointly by Dr. R. Kahn and by the present researcher. Also administered to all subjects was a standard interview to gather demographic information, medical, personal, and reading histories.

All verbal data were tape-recorded; interview time per normal subject ranged from two to five hours. Informed consent was obtained from all participants.

Linguistic Measures

While responses to questions asked in all instruments constituted part of the linguistic data which were analyzed, three instruments will be discussed which were designed specifically for analysis of linguistic patterning. One of these procedures was the Token Test, designed by DeRenzi and Vignolo (1962) and later adapted by Spreen and Benton (1969). The Token Test provided the study with data at the syntactic and semantic levels of the semiotic hierarchy. A second procedure, designed for the collection of data at the syntactic level, was the Test for Syntactic Complexity, designed by Emery. This test provided data at the syntactic level, and at the word-internal morphological level as well (Table 1). The third linguistic instrument used was the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) which yielded data at phonological, lexical-morphological, and semantic ranks of the

semiotic system, although the examination does not use semiotic terminology as such. These three instruments will be discussed now.

Token Test —— . The Token Test consists of thirty-nine verbal instructions which are brief, simple, and yet of increasing linguistic complexity, in which the individual must process relationships between tokens of varying size, color, and shape ('show me a blue one', 'show me a circle', 'show me the blue circle', 'show me the small blue square', 'show me the large yellow square'). Increasing linguistic complexity is attained primarily through the use of prepositions; prepositions are used as the linguistic means of determining varying relationships between abstract factors of shape, color, and size ('touch the blue circle with the red square', 'move the green square away from the yellow square', 'put the green square beside the red circle'). In characterizing the linguistic nature of prepositions, Brown (1973), Dale (1976), and Luria (1973) point out that prepositions are relatively complex forms and have the concomitant property of late acquisition in language development.

The Token Test's questions are divided into six sections which are weighted, with points increasing directly with linguistic complexity; these sections consist of seven, four, four, four, four, and sixteen items with point allotments of 7, 8, 12, 16, 24, and 96 respectively, for a test total of 163 points. Two grading procedures were followed: (1) the standard procedure in which credit is given for each part of a question answered correctly, and (2) the procedure of dichotomization was devised in which points were given only when the entire question was carried out correctly; partial credits per question were not given as we wanted to evaluate semantic performance at the level of sentence integration rather than at the level of response to discrete words. The weighted point scale was retained so as to indicate performance in relation to increasing complexity. Additionally, we required our participants to repeat each question prior to answering it; this repetition served as a control for memory function; we then contrasted the repetition performance with the deeper form of semantic integration required to carry out the instruction.

Test for Syntactic Complexity —— . The Test for Syntactic Complexity (TSC) is a thirty-six item instrument devised on the basis of the works of Svedelius (1897), Head (1926), Goldstein (1942), and Luria (1973, 1980); some items were adapted from the Supplementary Language Tests of the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972). The TSC has a thirty-six

point total (one point per question) and consists of five sections. Four sections deal with various syntactic relations which are complex and were late to develop in the sequence of language learning (Brown, 1973; Dale, 1976; Luria, 1973): (1) prepositions of time sequence ('do you put on your stockings after your shoes', 'what season comes before Spring and after Autumn'), (2) passive subject-object discrimination ('the dog was bitten by the cat, which animal bit the other and which was bitten', 'the woman is seen by the man, who is seen and who did the seeing'), (3) possessive relationships of a reversible construction ('what is the relationship of your mother's sister to you', 'uncle's daughter', 'daughter's uncle', 'husband's sister', 'sister's husband'), and (4) communication of abstract and/or logical relations ('John runs faster than George but slower than Humphrey') versus the communication of narrative action events which are concrete and/or alogical ('John and Mary run to the store really fast'). The fifth section of the Test for Syntactic Complexity is a test for word-internal morphological function (Darden, 1982) devised so as to be able to compare performance at morphological and syntactic levels of the semiotic system.

The majority of the syntactic questions on the TSC were structured around a fundamental linguistic division between communications pertaining to the alogical, concrete, specific, and communications pertaining to the logical, abstract, relational, propositional, or ideational. At its base, the TSC represents an adaptation of these two linguistic paradigms, which were first formally delineated by Svedelius in 1897. We can look briefly at this theoretical underpinning of the TSC before moving on to describe the third linguistic instrument administered to our participants. Goldstein (1942) observed that, cutting across various sub-populations of brain injured persons, there occured consistent patterned disturbances in language which revolved around the dimensions of abstractness-concreteness, with brain injured persons showing impairment of abstract capacity in language function. In characterizing the concepts of concrete and abstract language, Goldstein pointed out that his use of these terms is akin to Hughlings Jackson's concept of "propositional speech", Henry Head's concept of "symbolic behavior in relation to speech", and Karl Buehler's concept of "representational speech". Goldstein found that his subjects, primarily war and accident victims, were unable to use words as designates for categories. In analogue to Goldstein's concepts of abstractness-concreteness, Luria focused on the dimensions of logicality-alogicality in language structure. Basing his

conclusions on thirty years of observations of persons with compromised brain tissue, Luria (1973) stated that these persons had "great difficulty in understanding grammatical relationships such as 'the father's brother' and 'the brother's father'; 'spring before summer' and 'summer after spring', whereas the understanding of simpler grammatical structures remained unimpaired" (p. 40). Basing his models on the work of Svedelius, Luria delineated two models of syntactic structures, one model expressive of concrete narrative events, the other model expressive of abstract logical relationships. In describing the rationale behind the two models, Luria stated that "the logical-grammatical relationships cannot be visualized in concrete terms, they express abstract relationships. The patients . . . although understanding narrative speech (of the type 'father and mother went to the cinema but grandmother and the children stayed at home') perfectly well, cannot understand a sentence consisting of the same number of words, but incorporating complex logico-grammatical relations (such as 'a lady came from the factory to the school where Nina was a pupil to give a talk')" (p. 152).

To conclude, the Test for Syntactic Complexity is based upon a fundamental linguistic structural subdivision, previously used for discrimination of brain damaged from normal populations, which we have adapted for purposes of investigating linguistic patterning in normal healthy elderly persons as well as in elderly persons with senile dementia of Alzheimer's type.

Boston Diagnostic Aphasia Examination —— . The final instrument to be described is the Boston Diagnostic Aphasia Examination. It is a twenty-eight page examination consisting of eleven major testing areas: fluency, auditory comprehension, naming, oral reading, repetition, paraphasia, automatic speech, reading comprehension, writing, music, and parietal function. Study participants were tested in all areas excepting writing and music. The examination consists of forty-three subtests; most subtest scores can be interpreted within the context of a z-score profile included as part of the examination. The Boston Aphasia Exam provided our study with data at the phonological, lexical-morphological, and semantic levels of the semiotic hierarchy.

No time limits were imposed on our participants; the research interest was in the quality of performance independent of speed. It is well established that psychomotor slowing occurs as part of normal aging (Botwinick, 1978), and also that the process of senile dementing involves an accelerated slowing of all cortical functions, therefore it was important not to confound the known variable of psychomotor slowing with the variables of higher order corti-

cal function we were trying to measure and understand.

Statistical significance was determined by Difference of Means Tests, either model 1 for equal variances or model 2 for unequal variances, depending on F-test results. Also used were Difference of Proportions Tests.

RESULTS

The results of the present study of language and aging show that there exist significant differences between the normal pre-middle-aged and the normal elderly groups on the Token Test and Test for Syntactic Complexity, while there were no significant differences between the two groups on the Boston Diagnostic Aphasia Exam, the least complex of the three linguistic instruments, with the exception of speed of response. The sample of elderly with Alzheimer's dementia differed significantly from both the normal pre-middle-aged and the normal elderly on all measures.

Test for Syntactic Complexity ——— . The mean score of the pre-middle-aged sample was 33.1, out of a possible 36, while the mean score for the normal elderly sample was 24.4 ($t = 7.58$, $p = .0001$)(Table 4). A data breakdown of the normal elderly sample into younger and older halves yields a significantly different set of means with the younger half (mean age = 78.5) having a TSC mean of 26.2 and the elderly half (mean age = 88.2) having a mean of 22.5 ($t = 2.12$, $p = .05$). Another data comparison, this time between the pre-middle-aged sample and the younger half of the normal elderly, yields a difference of means of 33.1 and 26.2, respectively ($t = 4.19$, $p = .001$). All the statistical analyses point to an inverse relation between syntactic performance and age (Table 4, Table 5).

The Test for Syntactic Complexity has, as we stated previously, 36 points per test or a total of 720 points for 20 tests (36 points x 20 subjects per sample); of these 720 points, the normal pre-middle-aged sample missed a total of 58 points between them, while the normal elderly missed a total of 216 points as a group. A data analysis by sections shows the following breakdown in errors.

Section I consists of six questions incorporating prepositions of time sequence. The pre-middle-aged, as a group, missed 11 points in this section, while the normal elderly missed a combined total of 28 points ($t = 2.97$, $p = .01$). Nine elderly missed the question 'what season comes before Spring and after Autumn'; eight elderly persons missed 'what time is it when it is eight hours before Midnight and four hours before eight o'clock at night'; and five missed 'what time is it when it is ten hours after six o'clock at night'. The

remaining six errors were distributed over the rest of the items.

Section II consists of six questions of passive subject-object discrimination. Of the twenty participants in the pre-middle-aged sample, only one person missed two questions in this section. In startling contrast to the two points missed by the pre-middle-aged sample, the normal elderly missed 46 points ($t = 7.10$, $p = .0001$). Thirteen elderly incorrectly responded to 'the wolf was killed by the dog, which animal is dead'; ten elderly gave the wrong answer to 'the dog was killed by the wolf, which animal killed the other'; nine made an error on 'the dog was bitten by the cat, which animal bit the other and which was bitten'; five answered incorrectly 'the teacher is easy to see by the girl, who sees the other easily'; five were incorrect on 'the truck is damaged by the motorcycle, which vehicle damages the other'; and four of the normal elderly missed the question 'the woman is seen by the man, who is seen and who did the seeing'. Passive subject-object discrimination, which represents a complex task linguistictally (Brown, 1973; Dale, 1976), was dramatically more difficult for the normal elderly, who tended to repeat the test question aloud several times before responding, than for the pre-middle-aged, who tended to make the response quickly and without hesitation.

Section III of the Test for Syntactic Complexity involves eight questions relating to possessive relationships of a reversible construction. The pre-middle-aged missed a total of 17 points on these questions, while the normal elderly missed a total of 49 points ($t = 4.42$, $p = .001$). The most difficult possessive relationship for both the pre-middle-aged (4 errors) and the normal elderly (12 errors) was 'if a person is your grandfather's daughter-in-law, what is the relationship of that person to you'. Nine elderly missed both 'if a person is my daughter's uncle, what is the relationship of that person to me' and 'if a person is your brother's father, what is the relationship of that person to you' in contrast to one and two pre-middle-aged persons who missed these questions. Eight elderly missed 'if a person is my uncle's daughter, what is the relationship of that person to me', and the remaining eleven points were distributed over the other four questions.

Section IV of the Test for Syntactic Complexity consists of eight sentences, four of which code communication of narrative action concrete events and four of which code communication of logical and/or abstract relations (Luria, 1973, 1980; Svedelius, 1897). Memory load was controlled by having paired sets of communications with identical numbers of words across paired sets. Each subject was asked to repeat the sentence prior to answering ques-

tions so as to provide a comparison between the remembering of a sentence and the linguistic processing of the two syntactic forms. For each sample of twenty subjects, there were eighty points possible in anwer to questions dealing with logical relations (4 sentences x 20 subjects), and another eighty points dealing with narrative events (4 sentences x 20 subjects), for a possible total sample score of 160 points in this section. The normal pre-middle-aged made a total of 28 errors in this section, while the normal elderly made a total of 74 errors ($t = 5.52$, $p = .0001$). Of the 28 errors made by the pre-middle-aged, 24 errors occurred on the communication of relations, while only 4 errors were made on the communication of events. Looking at the normal elderly, of the 74 errors made, 66 occurred on the communication of relations, and only 8 on the communication of events ($t = 7.70$, $p = .0001$). Keeping in mind that the sentences coding the communications of relations were matched exactly in word length with sentences coding narrative events, this difference in errors is striking, certainly underscoring the findings of Luria and Svedelius regarding the difference in complexity which inheres between these two syntactic models.

A breakdown in errors shows the following. Starting with the longest sentence pair (16 words per sentence), the statement coding narrative events ('father and mother went to the movies but the grandmother and the children stayed at home') yielded 5 errors from the normal elderly, while the statement incorporating logico-grammatical relations ('a lady came from the factory to the school where Nina was a pupil to talk') resulted in 18 errors by the normal elderly. The next comparison involves sentences of thirteen words per sentence. The narrative communication ('Sue and Mary and John run to the store to get some candy') resulted in 3 errors by the normal elderly, while the more complex statement incorporating embedded clausing ('Sue noticed that the store where Mary worked was where John had run') resulted in 13 errors by the elderly. Turning next to the nine-word set of sentences, the narrative communication of 'John and Mary ran to the hospital really fast' resulted in no errors by the elderly, while the equivalent length sentence coding logical relations ('John runs faster than George but slower than Humphrey') resulted in 17 errors by the elderly. Similarly, an eleven-word sentence coding narrative events ('John ran to the store and Mary ran to the store') resulted in no errors by the elderly, while eighteen persons (almost the entire sample) missed the one-word shorter sentence expressive of logical relations of a

transitive type ('Mary is paler than Louise who is paler than Sonia'). Almost all the errors of the elderly occurred in syntactic processing rather than at the level of repetition; with the exception of the longest sentence set (16 words), the normal elderly had no difficulty with repetition. The evidence points to an inverse relation between sentence comprehension and syntactic complexity.

Section V of the TSC consists of eight test items at the morphological level rather than the syntactic level of the semiotic hierarchy. As stated previously, the morphological level pertains to parts of words/words while the syntactic rank deals with phrases and sentences. In our study, morphological analyses occured both at the lexical (vocabulary) level and at the word-internal morphological (inflectional) level. This fifth section of the Test for Syntactic Complexity deals with word-internal morphology wherein the task relates to structural changes within a word, i.e. changes of verb tense or conjugation. The subject was asked to first, repeat after the examiner, one at a time, all eight sentences. After the repetition task was completed, the subject was asked to change the verb tense or fill in the missing verb tense in each sentence. The pre-middle-aged made no errors in this section, while the normal elderly made 19 errors ($t = 4.51$, $p = .001$).

The final data analysis to be discussed here is between the normal elderly performance on the syntactic tasks of the TSC and the normal elderly performance on the morphological tasks of the TSC; this difference of proportions (216/500 errors as contrasted with 19/160 errors) yields a t-value of 6.36 and a significance level of .0001, indicating that the normal elderly performed significantly worse at the syntactic as opposed to the morphological level of the semiotic hierarchy.

Token Test ——— . As described previously (p. 6), the Token Test is a thirty-nine item instrument consisting of a series of instructions of increasing linguistic complexity in which the participant must process tokens of varying shape, color, and size. The Token Test is regarded as a very simple test for normal individuals (DeRenzi & Vignolo, 1962). The instructions consist of items such as 'show me a green circle', 'put the white circle in front of the blue square', 'touch all circles except the green one', the first item being one of the easier and the latter two being among the most difficult on the test. The simplicity of the Token Test was reflected both in the attitude and in the scores of the pre-middle-aged persons, the attitude being one of ease and spontaneity, with accompanying comments such as "this is kid stuff",

and with fifteen of twenty persons receiving perfect scores. In contrast, only two of the normal elderly received perfect scores, and the atmosphere during the test was one of greater effort and concentration than for the pre-middle-aged. As was stated in the section on methodology, it is known that normal aging has the concomitant of psychomotor slowing; in consequence, no time limits were imposed on participants. And, to control for memory load, participants were asked to first repeat the instruction; the normal elderly, overall, had no difficulty repeating these quite brief instructions. Nevertheless, the normal elderly missed a total of 683 points between them out of a possibility of 3260 points (163 test total x 20 subjects), while the pre-middle-aged missed only 62 points as a group. The mean score of the pre-middle-aged was 159.9 with a standard deviation of 6.7, whereas the mean score of the normal elderly sample was 129.9 with a standard deviation of 21.2 ($t = 5.89$, $p = .0001$)(F-test showed signficant difference between standard deviations, thus difference of means test for unequal variances was used). In subdividing the normal elderly into younger and older halves, it was of interest to see that the younger half (mean age = 78.5) had a Token Test mean of 142.4 while the older half (mean age = 88.2) had a mean of 117.3 ($t = 3.13$, $p = .01$). A data comparison between the pre-middle-aged Token Test mean of 159.9 and the test mean, 142.4, of the younger half of the elderly yields a t-value of 4.19 ($p = .001$). All the data analyses point to an inverse relation between linguistic processing and age.

Of the total of 683 points missed by the normal elderly on the Token Test, 508 of these points were missed on the last section which consists of sixteen instructions, fourteen of which utilize prepositions for attaining linguistic complexity greater than that in preceding sections. We can recall that prepositions are relatively complex linguistic forms, missing from Stage I language development, and mastered late in the learning sequence (Brown, 1973; Dale, 1976). Because of the inhering complexity of prepositions, Luria (1973) used prepositional statements as a diagnostic screen for organic brain damage.

The Token Test was designed as a "test of ascending linguistic complexity constructed to pick up non-obvious language disturbances". DeRenzi and Vignolo, in designing the test, stated "the test should include the least possible difficulty on an intellectual level, so that any individual may be able to perform the tasks correctly . . . the difficulty must lie in the lack of redundancy of the message transmitted and in the necessity, which this en-

tails, of grasping significance from the semantic value of every single word . . . lack of redundancy to this extent rarely occurs in everyday conversation" (1962, p. 667).

In sum, it is instructive to see that the normal elderly, in the absence of semantic redundancy, and in the presence of syntactic forms which are complex and mastered late in language development, show a signficant decrement in semantic processing at the level of sentence integration when compared to the pre-middle-aged.

Boston Diagnostic Aphasia Examination —— . There were no significant differences between the normal elderly and the pre-middle-aged in any of the major areas tested; subjects in both these normal samples had perfect/near-perfect scores throughout the Boston Diagnostic Aphasia Examination. In contrast, the elderly with Alzheimer's dementia performed significantly worse, making many errors, the patterns of which are delineated elsewhere (Emery, 1982, 1983a, 1983b; Emery & Emery, 1983). The Boston Diagnostic Aphasia Exam is the least complex of the linguistic instruments given our participants. Considering that the Boston Diagnostic Examination is a screen for aphasia, a clinically observable pathology defined as a "neurologically central disturbance of language characterized by paraphasias, word finding difficulty, and variably impaired comprehension . . ." (Kertesz, 1979, p. 2), the study findings make sense. Had any of our subjects shown readily observable language pathology, they would not have been included in the normal samples of the study, which by definition, required lack of pathology on all clinically observable parameters. Rather, what we have found with our study is that the normal elderly, while having no gross easily observable language deficits, upon closer inspection, show non-obvious subtle language disturbance in the context of complex linguistic tasks. The subtle language decrement of the normal elderly appears not to be random; the pattern underlying such decrement will be discussed next.

DISCUSSION

We will analyze now the pattern of linguistic deficits of the normal elderly. The results of the present study point to a direct relationship between language deficits and age, a direct relationship between language deficits and linguistic complexity, and what appears to be, the concomitant inverse relationship between sequence in language deterioration and sequence in language deve-

lopment, i.e. the more complex the linguistic form, the later the development of that form (Brown, 1973; Chomsky, 1969; Dale, 1976), the quicker the deterioration of that linguistic form. Further, there is a direct relation between decrement in the linguistic performance of the normal elderly and degree of structuredness (as opposed to open-endedness) of the linguistic task, and a direct relationship between linguistic decrement and lack of redundancy in the linguistic task.

The direct relationship between age-correlated language deficits and linguistic complexity is in evidence both across the ranks of the semiotic hierarchy and within the ranks of the hierarchy. The results of our study show that at the most elemental rank of the semiotic hierarchy, the phonological rank of sound without meaning, there were no signficant differences between the pre-middle-aged and the normal elderly. However, our tests of phonology, the Boston Diagnostic Aphasia Exam subtests of oral and verbal agility, repetition of sounds, phonetic association, were less structured and demanding than those of Benjamin (1982), who found that the elderly had significantly less phonological competence than younger adults.

For the lexical-morphological level (vocabulary) of the semiotic hierarchy, the Boston Diagnostic Aphasia Exam included subtests for word discrimination, word recognition, body-part identification, responsive naming, comprehension of oral spelling, and word comprehension through auditory, reading, and writing modalities. There were no significant differences between the normal elderly and the pre-middle-aged on lexical measures, with the exception of the variable of speed of response, which was not permitted to affect scoring. Our findings at the lexical-morphological level of the semiotic system are consistent with the results of other investigators (Horn & Donaldson, 1977) who found that vocabulary remains stable across adult years. However, some studies found significant changes in word fluency with age (Riegel & Birren, 1966; Schaie & Strother, 1968), but such changes may be interpreted as being a function of psychomotor slowing. A challenge to the finding of stable lexical function with age comes from a study invoking rigorous qualitative, as well as quantitative, criteria for lexical performance, in which it was found that quality of definition undergoes deterioration with age (Botwinick et al., 1975); this study result is not inconsistent with our overall finding that the gap in linguistic processing between young and old adults widens directly with increase

in linguistic complexity, logicality, abstraction, structured demand, and lack of redundancy and other cues. Also, all these data are consistent with the finding of Olber and Albert (1981) that active as opposed to passive vocabulary skills may deteriorate with age; our lexical measures were passive, while the Botwinick study required active lexical response.

At the word-internal morphological (inflectional) level, a subdivision of morphology more complex than the lexical level, there were significant differences between the normal elderly and the normal pre-middle-aged.

Moving to the syntactic level of the hierarchy, a level more complex than the morphological level, the study results indicate that the normal elderly do significantly worse at the syntactic than at the morphological level. Further, on every measure of syntactic function, there are highly significant differences between the normal elderly and the pre-middle-aged; the normal elderly consistently show evidence of decrement in syntactic function as a correlate of age. The syntactic variables of passive voice subject-object discrimination, prepositions of time sequence, possessive constructions of a reversible form, communication of complex logical, abstract relations in contrast to communication of concrete narrative events all posed greater problems for the normal elderly than for the pre-middle-aged; these syntactic forms have the common feature of late development in the sequence of language learning, and concomitantly, are among the most complex of linguistic forms. These data suggest an inverse relation between sequence in language development and sequence in language deterioration.

The study findings point to a negative regression between age and syntactic processing in the second half of the life span. Looking momentarily across the entire life span, the relation between syntactic performance and age would appear to approximate a curvilinear regression, because from birth to approximately age ten, there exists a positive relation between syntactic processing and age, i.e. the higher the age, up to ten, the higher the capability related to syntactic processing (Chomsky, 1969). Syntactic processing after the age of ten has not been investigated systematically prior to our research, insofar as we know. However, even with our research, we cannot tell at exactly what decade in the adult segment of the life cycle the decline (or negative regression between score and age) begins to occur with consistency. In other words, given a curvilinear (skewed curvilinear) realtionship where there is a positive relation between age and score on syntactic processing

up to age ten, and a negative relation between age and score on syntactic processing after the age of seventy-five, we still don't know for what period of time during the intervening segment of the life span, syntactic function remains stable. In an attempt to gain information on this question, we did a data analysis within the pre-middle-aged sample, calculating Pearson correlation coefficients between age and score. The resulting coefficients were not statistically significant, although the beginning of a negative regression between age and syntactic function was clearly in evidence (Emery, 1982). Thus, in order to understand further the changes which begin somewhere in mid-life, it will be necessary to add persons who are forty, fifty, and sixty years of age to the research design.

At the semantic rank of the semiotic system, the final rank to be considered, the processing of meaning can be analyzed at differing unit levels, such as the unit level of the word or the unit level of the sentence. At the level of the word, we found no significant differences between the normal elderly and pre-middle-aged in lexicon, whereas there are significant differences between the two groups in word-internal morphological function. And, at the level of the sentence, the data show that the more abstract, complex the structure of the sentence, the greater the decrement, and the less the decoding of meaning by the normal elderly; the gap between the normal elderly and the pre-middle-aged widens directly with an increase in the dimensions of complexity. Further, the semantic integration of the elderly, at the level of the sentence, is inversely related to the structured demand (as opposed to open-endedness) and lack of additional cues in the linguistic context.

To conclude, the results of a previously little researched topic, that of linguistic patterning in the aged, have been presented with the finding that diminished linguistic processing appears to be a concomitant of normal aging. Further, the results of the study point to a definitive sequence of deficits in linguistic patterning; linguistic decrement does not occur in a random manner, but rather seems to follow an orderly and predictable progression. Language is a cognitive process, essential for normative human interaction. Language is also a developmental process; the study which has been delineated provides the beginnings of answers to questions relating to a change in linguistic processing as a function of normal aging.

Table 2. Raw Scores for Normal Pre-Middle-Aged

Occupation	Age	Token Test[a]	Test for Syntactic Complexity
Maximal Score Possible		163	36
Males			
Mechanic	30	163	36
Mental Health Clerk	33	163	33
Janitor/Handyman	35	163	34
Mental Health Clerk	37	163	36
Unemployment Bureau	37	163	31
Salesman/Rubber Company	37	135	25
Owner/Motorcycle Shop	39	163	36
Owner/Book Store	39	151	35
X-Ray Technician	40	163	33
Upholsterer	41	153	28
Females			
Artist	31	163	36
Telephone Operator	33	163	30
Housewife	34	163	33
Computer Operator	35	163	32
Potter	36	163	35
Housewife	37	163	35
Housewife	37	163	36
Secretary	37	163	34
Nurse's Aide	38	157	32
Telephone Operator	42	157	32

[a] dichotomous scoring procedure - no partial credits, see p. 6 of text.

Table 3. Raw Scores for Normal Elderly

Occupation	Age	Token Test[a]	Test for Syntactic Complexity
Maximal Score Possible		163	36
Males			
Assistant Librarian	76	157	24
Janitor/Handyman	76	118	22
Fundamentalist Preacher	81	148	25
Engineer	81	163	32
Railroad Conductor	83	120	18
Notary Public	85	113	20
Farmer	88	85	20
Owner/Men's Clothing Shop	90	117	21
Banker/Founder University	90	138	29
Legislator	93	110	23
Females			
Teacher's Aide	75	142	27
Manager/Dress Shop	76	133	28
Published Poetess	76	135	29
Housewife	77	145	26
Housewife	84	163	31
Dry Cleaning Clerk	84	151	25
Registered Practical Nurse	84	101	16
Housekeeper	87	133	22
Housewife	90	102	24
Pianist	91	123	25

[a] dichotomous scoring procedure - no partial credits, see p. 6 of text.

Table 4. Comparison of Test Means by Sample

Sample		Mean Age	TT	TSC	CTS[a,b,c]	PT[a]	WMS[a]
Maximal Score Possible			163	36	100	5	82
Pre-Middle-Aged		36.40	159.90	33.10	90.35	4.5	62.00
Normal Elderly		83.35	129.85	24.35	57.95	2.7	47.10
Alzheimer Elderly[b,c]		80.25	26.40	5.35	13.25	.6	11.68
Pre-Middle-Aged							
Normal Elderly	t-value		5.89	7.58	9.19	5.92	5.35
	significance		.0001	.0001	.0001	.0001	.0001
Normal Elderly							
Alzheimer Elderly	t-value		13.75	12.88	10.64	6.25	12.43
	significance		.0001	.0001	.0001	.0001	.0001

Note: N equal 20 per sample, df equal 38 for Difference of Means Tests, Blalock, 1972.

[a] These data presented at 36th Annual Scientific Meeting of Gerontological Society of America, San Francisco, California, November 19, 1983, but not detailed in present paper

[b] For discussion, see Emery, 1982

[c] For discussion, see Emery and Emery, 1983

TT -Token Test, for scoring procedure, see p. 6 of text

TSC -Test for Syntactic Complexity

CTS -Chomsky Tests of Syntax

PT -Piagetian Tests for Stage of Thought

WMS -Wechsler Memory Scale

Table 5. Comparisons of Test Means of Pre-Middle-Aged Sample with Normal Elderly Sample Subdivided

Sample	Mean Age	Token Test[a]	Test for Syntactic Complexity
Maximal Score		163	36
Pre-Middle-Aged	36.40	159.9	33.1
Normal Elderly:			
Younger Half	78.50	142.4	26.2
Older Half	88.20	117.3	22.5
Pre-Middle-Aged			
Elderly Younger Half	t-value	4.19	5.23
	significance	.001	.0001
Elderly Younger Half			
Elderly Older Half	t-value	3.13	2.12
	significance	.01	.05

Note: N equal 20 per sample; normal elderly equal 10 per subdivision.

[a] For scoring procedure, see p. 6 of text.

Table 6. Test for Syntactic Complexity: Difference of Proportions Tests[a] Normal Elderly Compared to Pre-Middle-Aged

Test Section	Normal Elderly	Pre-Middle-Aged	t-value	Significance
I Prepositions Before-After	$\frac{92}{120}$	$\frac{109}{120}$	2.97	.01
II Passive Voice Subject-Object	$\frac{74}{120}$	$\frac{118}{120}$	7.10	.0001
III Possessive Relations Reversible Construction	$\frac{111}{160}$	$\frac{143}{160}$	4.42	.001
IV Communication Relations versus Communication Events	$\frac{86}{160}$	$\frac{132}{160}$	5.52	.0001
V Word-Internal Morphology	$\frac{141}{160}$	$\frac{160}{160}$	4.51	.001

[a] Tests of significance of difference of proportions of correct answers.

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